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Article

Contribution of Small-Scale Gum and Resin Commercialization to Local Livelihood and Rural Economic Development in the Drylands of Eastern Africa

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Abstract: This paper examines the extent to which the economic gains derived from gum and resin commercialization impact rural livelihood improvement under different resource management regimes in the drylands of Ethiopia and Sudan. Primary data were collected through semi-structured interviews with 240 randomly selected small-scale producers in four regions with gradients of resource management regimes. The survey was supplemented by secondary data, group discussions and key informant interviews. In the four regions, gum and resin income contributes to 14%–23% of the small-scale producers' household income. Absolute income was positively correlated with resource management regime and commercialization level. It was higher from cultivated resources on private lands, followed by regulated access to wild resources. In open-access resources, the producers' income was the lowest, although accessed by the poor and women. However, dependence on gum and resin was higher in open-access resource areas. Households' socioeconomic characteristics, resource access, production and marketing variables determining income from gum and resin were identified and their variation across the cases

is discussed. Overall, gum and resin commercialization in the study areas play a potential poverty alleviation role as a source of regular income, a safety net, and a means of helping producers move out of poverty.

Keywords: gums and resins; livelihood; poverty alleviation; resource management regime; Ethiopia and Sudan

1. Introduction

The role of forestry in general and non-timber forest products (NTFPs) commercialization in particular for rural livelihood improvement and poverty alleviation in the developing world has been discussed extensively in the specialist literature [1,2]. Due to the accessibility of NTFPs to the poor and marginalized groups in the community, and because they already comprise part of their livelihood system, governmental and non-governmental development agencies have incorporated NTFP commercialization in their poverty alleviation efforts [2,3]. However, despite the large number of studies discussing the poverty mitigation role of NTFPs [1,2,4,5], their current and potential role in poverty reduction is not well documented and hence still a matter of debate [5]. Consequently, the gap in systematic knowledge on the extent to which and how NTFP commercialization contributes to poverty alleviation and rural economic development calls for much research in order to shed light on the subject. In addition to the diverse nature and management of NTFPs, the development outcomes of their commercialization are shaped by a range of interrelated geographical and socioeconomic factors [3,6,7]. The situation calls for more comparative studies to investigate and capture the effect of those factors within specific socioeconomic, institutional and ecological contexts of the commercialization process.

NTFPs constitute an important source of livelihood for millions of people worldwide [1,8,9]. Although these forest products have been extracted by humans for subsistence use and trade perhaps for millennia, the interest in NTFP commercialization increased rapidly in the 1980s, following social concern in benefitting local communities and conserving tropical forests [3,10,11]. The influential work by Peters *et al.* [12], which revealed the economic value of NTFPs in the Amazonian rainforest, changed the perception on NTFPs and the traditional focus of forest management for timber products. According to Arnold and Ruiz Pérez [13], the global attention on NTFPs as a means for development and conservation of tropical forests derived from: their potential contribution for rural household livelihood and national economies; the fact that their extraction is assumed to be less destructive than timber; and the increasing market value that creates an incentive to the local community to conserve forests. Despite their significant role in the livelihood of rural and urban dwellers [1,14–16], the initial assumption of simultaneous achievement of development and conservation objectives through NTFP commercialization has been a subject of debate in the NTFP discourse [13,17].

NTFPs contribute to rural economic development in different ways. Several studies highlighted the strong link between poverty and dependence on NTFPs [1,2,11,13]. In the forest–poverty nexus, three different roles of NTFPs for poverty alleviation are identified, distinguishing between poverty mitigation and poverty reduction [1,2,18,19]. First, many NTFPs are used to meet current consumption

needs as a regular part of subsistence-level livelihoods, thus playing gap-filling roles [20,21]. Secondly, NTFPs provide valuable safety net roles in times of emergency and during periods of hardship [13]. Thirdly, in some cases, commercial NTFPs may also provide a way to increase household incomes and a possible pathway out of poverty through accumulation of capital, savings and investment in productive assets to take up other activities as a stepping-out strategy or intensification of existing activities as a stepping-up strategy [9,22]. The first two roles of NTFPs fit into the poverty mitigation in preventing people from failing into deep poverty, whereas the latter contributes to poverty reduction by lifting rural households above the poverty line. As indicated by Belcher [2], more than the biophysical characteristics of the products, the socioeconomic and environmental context of the production, processing and marketing system are major determinants of how NTFPs contribute to rural livelihood improvement.

Dry forests and woodlands in sub-Saharan Africa, despite their fragility, are endowed with rich biodiversity and provide economic and ecological benefits to the society [8]. The resources are known for their extensive variety of high-value environmental products, including the diverse NTFPs [23]. Commercialization of NTFPs in the region offers an opportunity for income generation and livelihood diversification [4,24–26]. The drylands of East Africa, in particular, are known for their potential and long tradition of extraction and commercialization of natural gum and resin products, exudates from the genera *Acacia*, *Boswellia* and *Commiphora*, for the international market [27,28]. In the drylands of Ethiopia and Sudan, the woodlands dominated by *Acacia*, *Boswellia*, *Commiphora* species have a high potential for rural economic development. They are important sources of economically viable commercial NTFPs, including gum arabic, frankincense, myrrh and oppopanex. They represent important sources of livelihoods of the local community, employment and foreign exchange earnings [28]. In addition to the wider industrial applications in developed countries, the products are consumed locally as traditional medicines, foods and beverages, and are used in religious and cultural rituals [29].

Owing to the resource endowment and the associated comparative advantage arising from increasing international demand for the commodities, there is significant scope in the region to generate more value locally and induce rural economic development by supporting the upstream actors to build their livelihood options [30,31]. There is also a growing interest among development organizations to exploit the economic potentials for rural economic development. Through comparative analysis of multiple cases that represent gradients of resource management regime, this study provides a quantitative analysis on the contribution of natural gum and resin commercialization in rural livelihood and economic development in the drylands of Ethiopia and Sudan. The study was motivated by the following research questions: (i) To what extent does the economic gain derived from the small-scale production of natural gum and resins impact rural livelihood improvement and poverty alleviation? (ii) What factors explain the inter-household and regional (inter-case) variations in the level of income and dependence on gum and resin incomes? (iii) What lessons and recommendations can be drawn to promote rural economic development based on commercialization of high value NTFPs in the dryland regions of Ethiopia and Sudan?

2. Material and Methods

2.1. Description of the Study Areas

The study was conducted in four case study areas in the dryland regions of Ethiopia and Sudan, two in each country (Figure 1). The cases were selected based on a set of criteria: (i) abundant distribution of gum and resin-bearing tree species and environmental conditions favorable for commercial gum and resin production [32–34]; (ii) widespread extraction and trade of gum and resin [28]; (iii) local community involvement in extraction of the products; and (iv) representative gradients of resource access and management in a continuum of open-access wild resources to intensive management on private gum gardens; production systems ranging from collection of the natural ooze to production by tapping; and level of commercialization. The detailed biophysical and socioeconomic features of the case study areas are given below and a summary is presented in Table 1.

Table 1. Summary of the socioeconomic and biophysical characterstics of the study areas.

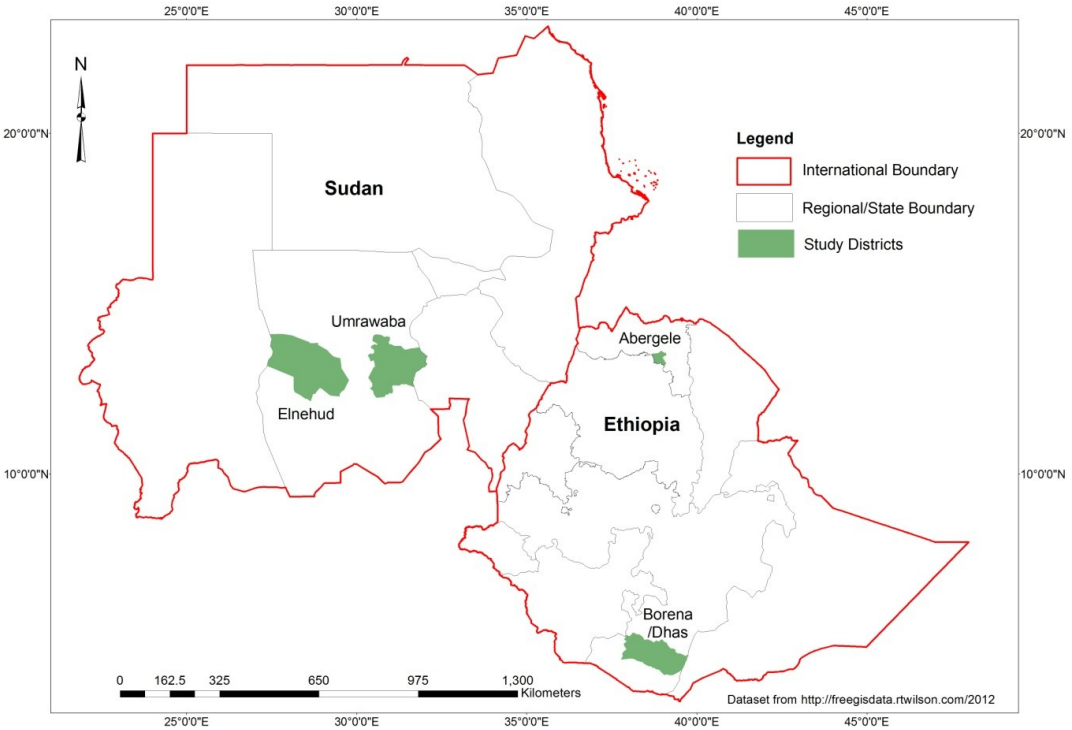
Variables	**Case study area**			
	Elnehud	**Ummrawaba**	**Abergelle**	**Borena**
Study villages	Direra, Helet Ismeal	Amanallah, Elmerhabiba	Tseykeme, Tarma	Dhass, Wolensu (Dhass District)
Geographical location	Central Sudan, North Kordofan 12°27′–13°15′ N 28°15′–29°55′ E	Central Sudan, North Kordofan 12°30'–14°15' N 30°20'–32°30' E	North Ethiopia, Tigray Region 13°10'–13°35' N 38°35'–39°05' E	South Ethiopia, Oromya Region 4°05'–4°25' N 38°39'–38°56' E
Topography	Flat terrain	Mostly flat terrain	Undulating with hills and valleys	Mostly plain with undulating areas
Vegetation type	*Acacia* woodland	*Acacia* woodland	*Combretum-Terminalia* woodland	*Acacia–commiphora* woodland
Dominant ethnic groups	Hameri	Gawama	Tigryan (~97%)	Borena oromo
Farming system	Mixed farming crop and livestock Rotational cropping with gum production	Mixed farming crop and livestock Rotational cropping with gum production	Mixed farming Subsistence and cash crops with livestock	Livestock production (pastoralist)
Commercial gum and resins and botanical sources	Gum arabic *A senegal*	Gum Arabic *A senegal*	White frankincense; *B papyrefera*	Borena-type frankincense and gum arabic; *B negelecta* and *A senegal*
Woodland resources tenure, access and management	Gum arabic predominantly harvested from gum gardens managed on private lands	Gum arabic predominantly harvested gum gardens managed on private lands	Frankincense mostly harvested in public woodlands, access managed by local authorities	Gum and resins harvested in communal woodlands, with open-access, managed by traditional institution

2.1.1. North Kordofan State: Ummrawaba and Elnehud

Ummrawaba and Elnehud provinces, selected from North Kordofan state of Sudan, are characterized by flat terrain and three main soil types: sandy, sandy clay, and alluvial flood plain soils at seasonal waterways. Sedentary agro-silvo-pastoral system including gum arabic production is the dominant land use in the provinces. The traditional rotational cropping system with *Acacia senegal* trees managed in fallow lands forms an integral component of the farming system in the areas. An important distinction between the two provinces is the higher soil productivity and dominance of animal husbandry in Elnehud. Moreover, the small-scale gum arabic producers in Elnehud are more cash oriented and have better access and links to urban markets.

The mixed farming system with a combination of rain-fed crop cultivation and livestock raising is the main source of livelihoods in the areas. Although the farming system in North Kordofan is generally characterized by smallholder farming with family labor and low inputs; it has traditionally been the major source of primary agricultural export production including sesame, hibiscus, ground nuts, gum arabic, watermelon seeds, and livestock products. The vegetation type in the area is typically *Acacia* woodland where *A. senegal* is the dominant tree species occurring both naturally as well as planted or managed natural regenerations following the traditional bush fallow [35]. *Leptadinia pyrotechnica*, *A tortolis*, *Albizia sericocephala*, *Combretum hartmannianum*, *Adansonia digitata*, *Balanites aegyptiaca*, *Grewia tenax*, *Guerea senegalensis*, *Zizphus spina-christi*, *Sclerocarya birrea* are among the common associated tree species. The rural community depends on the woodland resources for a variety of products and services including firewood, construction wood, gum arabic, edible wild fruits, traditional medicine and other NTFPs [35].

Figure 1. Map of the four case study areas in the drylands of Sudan and Ethiopia.



2.1.2. Abergelle

Abergelle district is located in the central zone of the Tigray region in northern Ethiopia, about 180 km southwest of the regional capital, Mekelle. It is one of the oldest frankincense production areas. The local community possesses accumulated experience in frankincense tapping, production and marketing of frankincense. The topography of the area is undulating terrain with an altitude range of 1400–1650 m above sea level. The farming system in the district is a mixed crop–livestock farming system. The main staple and cash crops cultivated include sorghum, maize, teff, sesame and flax (oil seed). The agricultural production is entirely dependent on the low and erratic rainfall. Soil fertility decline, pests and recurrent drought conditions are the main constraints affecting crop production and food security in the district.

According to Friis *et al.* [36], the vegetation type in Abergelle is classified as *Combretum-Terminalia* woodlands. The natural vegetation is dominated by *B. papyrefera* constituting about 44% of the total density [33]. *Boswellia* woodlands in the district are state property, with the local community having a use right. Access to those woodlands for frankincense production is regulated by the village administration that possesses *defacto* rights recognized by the district office of Agriculture and Rural Development.

2.1.3. Borena

The fourth case study area is selected in the Borena zone (Dhass district) of southern Ethiopia. The landscape of the area is mostly plain with some undulating terrain with an altitude range of 1000–1500 m above sea level [37]. It experiences arid to semi-arid climate with high variability in amount and distribution: the average annual rainfall ranges from 370 to 800 mm. The livelihood of the population is mainly based on livestock raising with a recent introduction of crop cultivation in home gardens. It is customary in this society to own as many animals as possible, irrespective of their condition and the availability of pasture. However, recurrent drought following low and erratic rainfall is a major challenge greatly affecting livestock production in the area. Collection of gum arabic, frankincense and myrrh has been going on in the area for quite some time, forming an important supplementary income for the pastoral households [34].

The vegetation of in Borena zone is classified as *Acacia-commiphora* woodland dominated by *Acacia*, *Commiphora*, *Boswellia* and allied genera with dwarf shrubs and grasslands [37,38]. The extensive rangeland is an essential resource in sustaining the pastoral way of life and provides a wide array of gum and resin products and essential services in economic and cultural terms. Thus, the pastoralists' livelihood is tightly linked with the woodland. The woodland resources are communally owned and managed by the traditional *Gada* system—a governing system where leaders are elected to positions of authority through the will and participation of the community and that is acknowledged by the local government [37].

2.2. Research Methods: Data Collection and Analysis

2.2.1. Data Collection

The study employed comparative multiple case study design [39] which entails the study of four contrasting cases using identical methods [40]. The research design apparently allows analysis and comparison within and across the different cases to capture similarities and variations. Primary data were collected during two field surveys conducted in 2011 and 2012, as part of a research project analyzing the value chain of gum and resins and their rural development potential in the drylands of Ethiopia and Sudan. A combination of qualitative and quantitative data collection methods [40] were used to gather both primary and secondary data. Prior to the field surveys, a review and analysis of secondary sources was conducted to gain general insight into the case study areas and issues related to production and commercialization of natural gum and resin in the regions.

The field survey started with key informant interviews (10 in Sudan and 8 in Ethiopia) at national and local levels, including experts and individuals who have first-hand information about the gum and resin production in the specific case study areas. The household survey was conducted with a total of 240 randomly selected household heads (60 producer households in each case study area). The questionnaires covered different issues related to the household socioeconomic characteristics; resource endowments and major livelihood sources; production, processing and marketing of gum and resin products; income and expenditure from gum and resin-based activities; interaction with other value chain actors; access to market and support services; perception on the commercialization process; and policy and institutional issues. It has to be noted that there could possibly be recall biases in the income data as we used a reference period of one year. Furthermore, 12 group discussions were held in the eight villages with the local leaders, producers' association leaders and producers to complement and verify the data collected through the household survey.

2.2.2. Data Analysis

The total household income, in the context of this study, represents the combined income that households generated from their main economic activities. Income from the major livelihood activities (crop, livestock, and forest) were calculated by multiplying the quantities sold by the actual sale prices (for cash income) or by the average local price (for subsistence income). Instead, the cash income from off-farm activities and remittance were recorded directly as the amount earned in the given recall period. All income results presented were calculated as net income, *i.e.*, gross value less costs of all purchased inputs including hired labor excepting family labor. Local units of measuring gum and resin traded were converted into metric units and financial values converted to equivalent purchase power parity (PPP) US$ using the respective PPP index of the two countries during the data collection period [41]. This has facilitated the comparison between cases in the two countries.

The data on contribution of gum and resin income to household livelihoods and the associated socioeconomic factors were analysed with a combination of descriptive statistics, ANOVA, *F*-test, correlation and multiple regression analysis using SPSS. Meanwhile, the data from qualitative interviews, group discussions and observations were analyzed qualitatively. The inter-household variations in the absolute and relative gum and resin income were analyzed by categorizing the

sampled households into income quartile groups. The absolute gum and resin income and level of dependency on it was then compared across the income quartiles. Furthermore, the determinants of absolute gum and resin income were identified using a stepwise multiple regression analysis. The role of gum and resin income in reducing poverty incidence (% of population below the poverty line of 1.25 US$ a day per capita income) and income inequalities among the rural community was examined by considering with and without scenarios in the household income accounting. Per capita income was calculated by dividing the total household income by the total family size regardless of the age categories within the household. The contribution of the additional income from gum and resin on poverty mitigation was evaluated by comparing the poverty incidence (headcount index) with the inclusion and exclusion of gum and resin incomes. The poverty incidence (P_i) in the sampled population was calculated using the formula given by the World Bank [42]:

$$Pi = \frac{Np}{N} \quad (1)$$

where, *Np* is the number of households with income below the poverty line and *N* is the total number of sample households.

In order to evaluate the effect of gum and resin income in reducing income disparities, the *Gini* (generalized inequality index) coefficient for total income was computed with and without gum and resin incomes. Following Deaton [43], the *Gini* coefficient was computed using the expression:

$$G = \frac{N+1}{N-1} - \frac{2}{N(N-1)\mu}\left(\sum_{i=1}^{N} Pi\, Xi\right) \quad (2)$$

where, *G* represents the Gini coefficient of the total income; μ is the mean income of the population; *N* is the sample size and *Pi* is the income rank *P* of person *i*, with income *X* such that the richest person receives a rank of 1 and the poorest a rank of *N*.

3. Results and Discussion

3.1. Livelihood Portfolio of the Sampled Households in the Study Areas

As is common in most of rural Africa [44], households in the four case study areas rely on a wide range of economic activities mainly related to natural resource extraction. Based on the household interviews, six major livelihood sources were identified, including agricultural crop production, livestock production, gum and resin, other forest products, off-farm activities, and remittances. Gum and resin income was treated separately from the aggregate forest-based incomes as it is the main subject of the analysis. Total household income in the context of this study represents the combined income generated from the main household economic activities. The contribution of the major income sources to the total annual household income is presented in Table 2. The household income analysis indicated that the average total household income ranges from 2,464 ± 88 US$ PPP in the pastoralist area, Borena, to 8,709 ± 639 US$ PPP in mixed cash crop and livestock farming area, Elnehud.

The rural communities in the study areas follow different livelihood strategies that might result from the socio-cultural and natural environmental conditions. It can be clearly observed from the

average household's livelihood portfolios that livestock production is by far the most important source of income in Borena, alone contributing to more than 60% of the total household income. The population in this region is mainly pastoralist depending on livestock production on extensive rangelands regulated by traditional institutions. The smallholders in Elnehud and Abergelle exhibit similar livelihood strategies that largely depend on mixed crop and livestock production, together constituting up to 65% and 75% of the total household income, respectively. On the other hand, subsistence farming and cash crop production forms the main livelihood source in Ummrawaba contributing the largest share (52%). The income analysis further exhibited substantial variation across the case study areas in the average total household income corresponding to the farming system of the areas, both in Ethiopia and Sudan, increasing from extensive livestock production to mixed farming with cash crop production areas.

Table 2. Households' livelihood portfolio (US$ PPP) in the four case study areas.

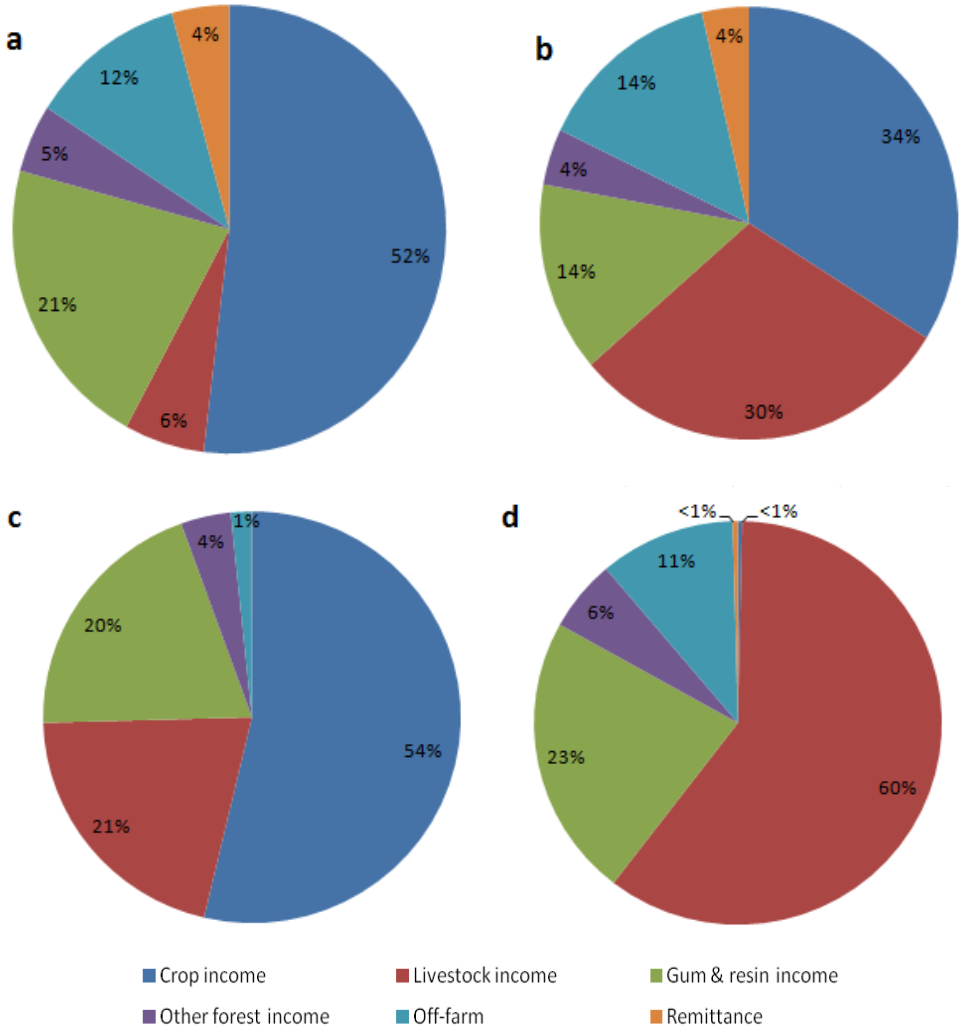
Major income source	Ummrawaba (*n* = 60)		Elnehud (*n* = 60)		Abergelle (*n* = 60)		Borena (*n* = 60)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Crop income	2,773.20	136.28	2,951.43	197.32	2,242.39	176.35	8.35	5.05
Livestock income	319.19	44.13	2,593.23	287.18	870.67	133.80	1,481.50	93.46
Gum and resin income	1,152.08	83.48	1,238.06	120.72	831.11	43.22	558.21	28.34
Other forest income	262.05	7.84	366.09	36.00	162.30	6.23	140.97	4.05
Off-farm	620.02	85.57	1,244.65	184.21	66.82	18.89	265.76	31.21
Remittance	229.17	34.56	316.29	79.91	1.52	1.52	10.02	4.57
Total	**5,355.71**	**201.29**	**8,709.74**	**639.95**	**4,174.28**	**254.37**	**2,464.08**	**88.15**

Source: Field survey 2011/2012; 1 US$ PPP = 5.49 ETB (Ethiopian Birr); 1 US$ PPP= 1.84 SDG (Sudanese Pound) during the survey period.

3.2. The Contribution of Gum and Resin Income to Household Economy

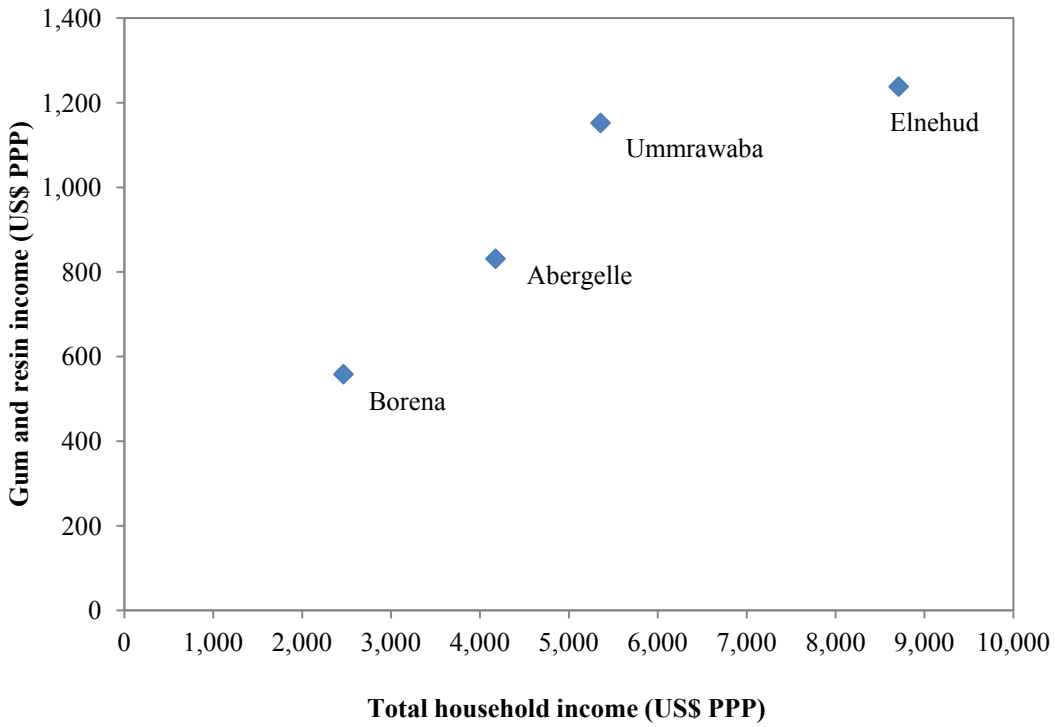
Gum and resin production and collection represent an integral part of households' livelihood sources in the study areas. These NTFPs generate considerable cash income contributing to 21%, 14%, 20% and 23% of the total household income in Ummrawaba, Elnehud, Abergelle and Borena, respectively (Figure 2). The contribution to the total household income was impressive as compared to the limited alternative income sources like off-farm income and remittance in both the cases analyzed. In the cases of Ummrawaba and Borena, the contribution is even more than that of livestock and crop income, respectively. The other interesting observation was that gum and resin commodities constitute a substantial share of the total forest income. Gum arabic and frankincense production and collection make 3–5 times higher income than the aggregate of other forest products collected by households which are mostly used for subsistence. The result confirmed the economic significance of the woodland and tree resources in the dryland regions of Sudan and Ethiopia, which are valued more for their commercial NTFPs—principally gum and resin products [8,29].

Figure 2. The share of major income sources in total household income across the study areas: (**a**) Ummrawaba; (**b**) Elnehud; (**c**) Abergelle and (**d**) Borena.



As expected, considerable inter-case variations were observed in the level of gum and resin income. ANOVA suggested statistically significant variation in the average household total income derived from gum and resin between the four case studies ($F = 15.12$, $P < 0.000$). The households in Ummrawaba and Elnehud earned the highest average annual income 1152 ± 83 and 1238 ± 120 US$ PPP from gum arabic production, respectively, followed by Abergelle (831 ± 43 US$ PPP). In contrast, the income from collection of gum and resins in Borena was relatively low at 558 ± 28 US$ PPP. This could be attributed to the poorly developed market and production system resulting in low production unlike the former three cases. The income variation basically corresponds to the gradient of the resource management, increasing from open-access wild resource (in Borena) to regulated access natural woodland (Abergelle) and to intensively managed gum gardens on private lands (Ummrawaba and Elnehud). In terms of production system, the average household production and income from gum and resins were the lowest where the production merely involves collection from natural oozes rather than tapping. Furthermore, the mean gum and resin income increased with the average total household income across the cases, reflecting the commercial value of the commodities having the characteristics of high value goods unlike most NTFPs (Figure 3).

Figure 3. Cross-case comparison of the relation between total household income *vs.* gum and resin income (US$ PPP).



The economic benefits from commercial gum and resin production and collection were higher in comparison with the available alternatives, thereby indicating the significant role of the activity in supporting the livelihoods of the small-scale farmers and herders in the study areas. Gum and resin income represented the second source of income in Ummrawaba and Borena, and third in Elnehud and Abergelle next to crop and livestock incomes. The group discussions also revealed that there are few off-farm income-generating activities, especially in the two Ethiopian cases. In Ummrawaba and Elnehud, migratory labor work in the nearby urban centers in addition to traditional gold mining are the common off-farm income-generating activities during the agricultural slack period. Thus, in the face of the limited alternatives and the prevailing environmental conditions affecting crop and livestock productivity, gum and resin production provides a viable livelihood option that offers major (cash) income-generating opportunities for enhancing and diversifying the household incomes [24,45].

3.3. Level of Engagement and Producers' Experience in Gum and Resin Production

A high rate of household participation in gum and resin activities was observed in the four study sites. According to the data from village leaders and the group discussions, almost all the community members in Borena and a large proportion of the households in Elnehud (98%) and Ummrawaba (86%) were engaged in gum and resin production activities during the survey periods. However, only 60% of the households participated in frankincense production in Abergelle, mainly due to the lack of access to the woodland resources. However, all the village members have an interest in frankincense production; the multipurpose cooperative allocates the production areas giving priority to cooperative members, with good experience of production, and households with less land. The group discussions in

the four cases also indicated that both the rich and poor segments of the rural community in the study areas were engaged in and depended on gum and resin production to a different extent.

Different reasons, all economic, were mentioned by the small-scale producer households explaining their motivation for engaging in gum and resin production and collection. Table 3 presents the frequency of the most rated reasons by respondents: economically attractive as source of immediate cash income, complementary to agriculture in terms of labor and land use, less income from agriculture, accessibility of the activity, and lack of alternatives. Consistent with the household income portfolio analysis, most of the producers across the case study areas (95% in Ummrawaba, 93% in Elnehud, 100% in Abergelle, and 77% in Borena) rated economic attractiveness of the activity for immediate cash income as the major factor for entering in the activity. Most of the producers in Borena mentioned the lack of alternative (80%) and free access (90%) and ease of the activity (75%) as their main reasons for producing gum and resin. On the other hand, as mentioned by respondents in Abergelle, the critical factor affecting entrance in frankincense production was access to the resource base. Due to the limited resource base, all the community members have no access to the communal woodlands for frankincense production. Local elites with better access to the local authorities usually tend to have better access to *Boswellia* woodlands, thus limiting the poor from sharing in the benefit from the wild resources.

Table 3. Motivations for entering in gum and resin production and number of years participating in the activities.

Variables	% of the respondents			
	Ummrawaba (*n* = 60)	**Elnehud (*n* = 60)**	**Abergelle (*n* = 60)**	**Borena (*n* = 60)**
Reason for engaging in gum and resin production *				
Economically attractive (Immediate cash income)	95.0	93.3	100	76.7
Less income from agriculture	68.3	51.6	61.7	41.6
No labor competition with agriculture	38.3	75	35.0	75.0
Accessibility of the activity and resource	46.6	66.7	3.0	90.0
Lack of alternative	35.0	6.7	33.3	80.0
Number of years in gum and resin				
<5 years	10.0	6.6	15.0	25.0
5–10 years	13.3	11.5	16.7	43.3
10–15 years	11.7	13.0	15.0	23.3
>15 years	61.7	68.9	53.3	8.3
Mean (Years)	21	20	19	10

***** The figures in the first variable (reason for engagement in gum and resin production) do not add up to 100% as the respondents provided one or more reasons; Source: Field survey (2011 and 2012).

The number of years that households engaged in gum and resin production and collection is presented in Table 3. The bivariate correlation analysis indicated a significant correlation of household heads' age with the number of years engaged in gum and resin production in Abergelle ($r = 0.670$, $P = 0.000$), Ummrawaba ($r = 0.534$, $P = 0.000$) and Elnehud ($r = 0.636$, $P = 0.000$), but not in Borena

(r = 0.094, P = 0.476). This could be attributed to the development of the business in the study areas over many years. Gum arabic and frankincense production has been a traditional activity in North Kordofan and the northern part of Ethiopia. Thus, most of the producers in Elnehud (68.9%), Ummrawaba (62%), and Abergelle (53.3%) had practiced gum and resin production for more than 15 years. In these regions, the income potential of gum and resin production is well recognized by the local communities as a major source of livelihood. Accordingly, gum and resin production can be considered as a stable and long-term source of income for the local community. However, the majority of the producers (68%) in Borena only began in gum and resin collection in the last 5–10 years. The low participation in the previous years could be attributed to the low market price of the products and the local tradition labeling the activity as "poor men and children business" [34]. However, in recent years, with the increase in the frequency of drought affecting livestock productivity and the development of gum and resin commercialization in the area, the local community has engaged in the collection and marketing of gum and resins regardless of their social and economic status.

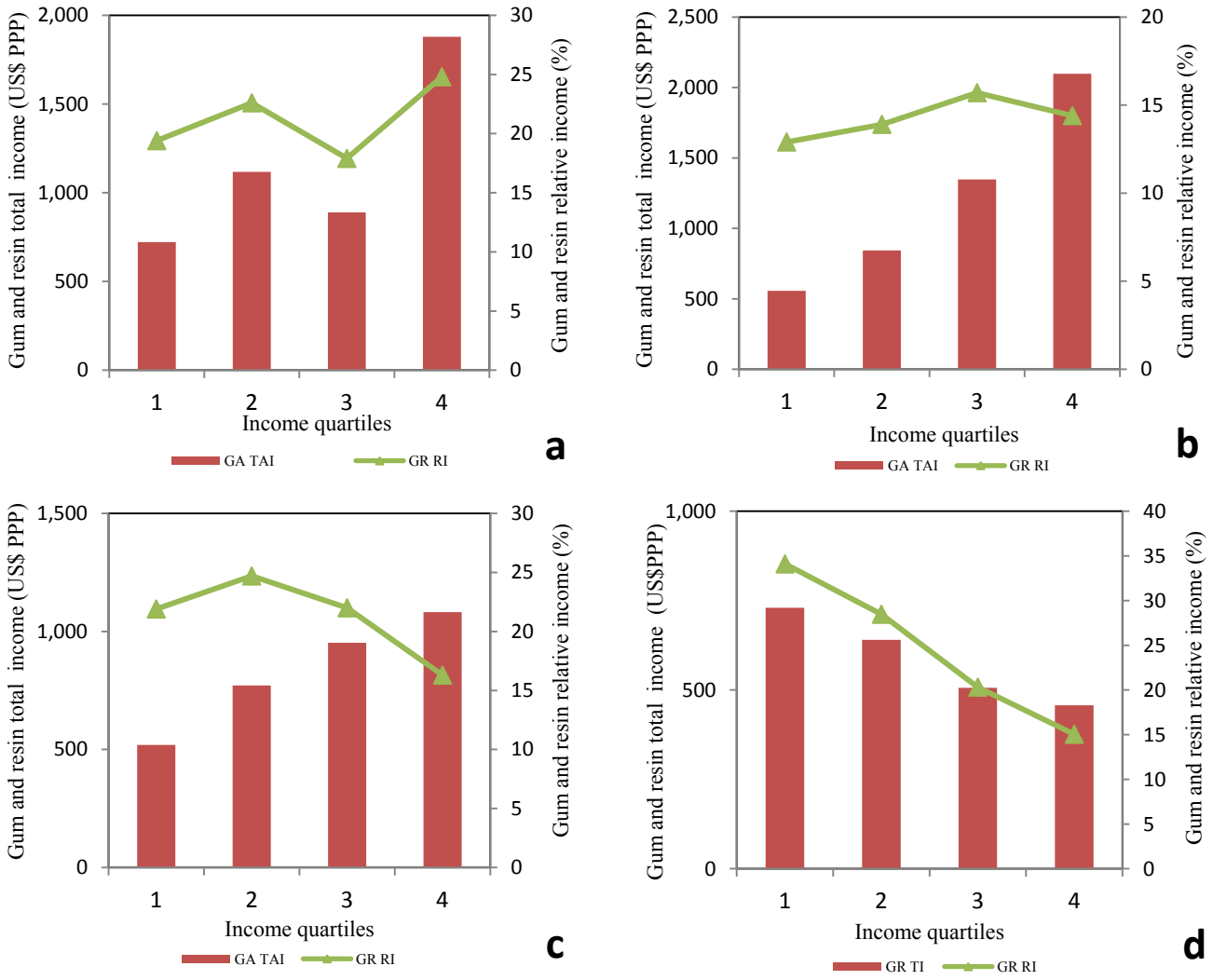
3.4. Absolute and Relative Gum and Resin Income across Income Quartiles

Figure 4 portray the absolute and relative contribution of gum and resin income to the total household income in different income quartiles. The comparative analysis revealed that the absolute and relative gum and resin income exhibit different patterns across the cases. The analysis of variance (ANOVA) confirm statistically significant difference in the gum and resin income between the income quartile groups in all the four cases areas (P = 0.000). The absolute income earned from gum and resin increases with the total household income in Ummrawaba, Elnehud and Abergelle (Figure 4a–c). This means that households in the higher income quartiles or better-off households obtain higher income from gum and resin production in quantitative terms than their counterparts in the lower quartiles. This could be related to their better access to resources and markets to exploit the opportunity from the commercialization of high value NTFPs. This finding concurs with the commonly reported trend whereby higher income households use greater amounts of forest products than lower income households [46–49].

On the other hand, a different pattern was observed in Borena, where households in the lower income quartile groups generated higher income from gum and resin than better-off households. In this case, the total gum and resin income decreases as one moves from the lower to higher income quartile groups (Figure 4d). This could be attributed mainly to the low barrier to entry in gum and resin collection because of the open-access resource and low return on labor of the activity [3]. This result is in line with the argument in previous works [2,13] that claim the accessibility of NTFPs for the poor and marginal groups of the community.

The observed different patterns of gum and resin income distribution observed across the income quartiles indicate the variant in the role of NTFPs in household livelihood with the increasing commercialization and hence value of the commodities [13]. The findings of the comparative analysis confirm the argument that forest product income in unrestricted resource access is particularly important for the poor, while with increased commercialization, the barriers could be higher resulting in the control of resources and market opportunities for the better-off households [11].

Figure 4. Absolute (TAI) and relative (RI) gum and resin income differentiated by income quartile groups across the case study areas (**a**) Ummrawaba (**b**) Elnehud (**c**) Abergelle and (**d**) Borena; $n = 60$ in all the cases.



Similarly, inter-household and inter-case variations in the extent of dependence on gum and resin income were analyzed. Looking at the relative dependence on gum and resin income (% of gum and resin income to the total household income), interesting patterns emerged. Consistent with the common hypothesis in the forest–poverty link [1,49], the relative dependence on gum and resin income decreases from the lower to higher income quartiles in Borena (Figure 4d). The variation in relative dependence was significant between the income quartiles ($F = 13.496$, $P = 0.000$). The poor households in this region are more dependent on gum and resin incomes than the households in the higher income quartile groups. The trend in relative dependence in Abergelle appears to be bell-shaped, with higher relative dependence of the households in the middle income quartile (Figure 4c). The ANOVA also revealed a significant difference in relative dependence among the income quartiles ($F = 3912$, $P = 0.013$). In Ummrawaba and Elnehud, the relative dependence on gum arabic income shows a general increasing trend with the total income (Figure 4a,b). These results contradict recent studies that disclosed the higher relative dependence of the poor on forest and environmental incomes [48,50]. However, it reflects the commercial value of the products with higher

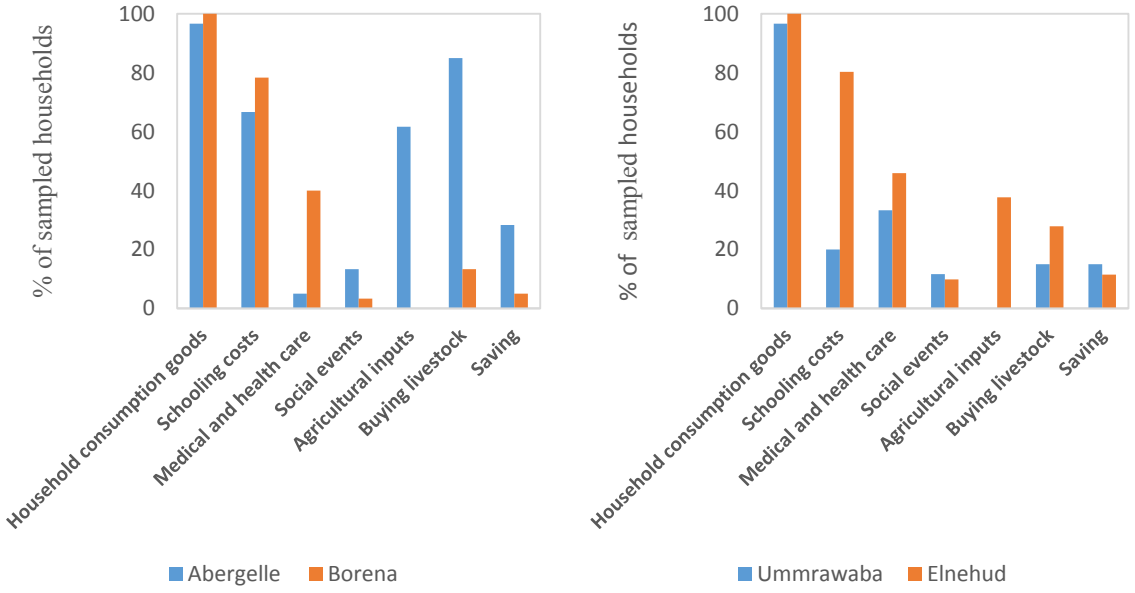
income opportunity for the poor and better-off households. The changing patterns in the relative dependence across the income quartiles in the four cases can also lead to an assertion that with the increasing commercialization of NTFPs better-off households exploit the emerging opportunities and depend more on them.

3.5. Expenditure Structure of Household Extra Income from Gum and Resin

Actual figures on total household expenditure are difficult to estimate as almost no households keep records; expenditure data were thus based on the respondents' recall for a period of one year. The paper therefore presents the frequency of the major expenditure items as proportion of the sample households. The households use the extra cash income from gum and resin production in different ways across the case study areas. The main expenditure items include household consumable goods, medical care, schooling costs, and social events, agricultural inputs, buying livestock, and saving. Figure 5 presents the proportion of households spending the additional income from gum and resin for the major expenditure items in the case study areas.

The descriptive analysis of expenditure shows that in all cases a large proportion (>95%) of the households used part of their gum and resin income for current consumption needs including food, drinks and clothes. A large proportion (>65%) of households also cover schooling costs from their gum and resin incomes in all the cases except in Ummrawaba, where 20% of the households used the extra income from gum arabic for schooling costs. As can be observed in Figure 5, 61%, 85% and 28% of the respondents in Abergelle used their frankincense income for agricultural inputs, livestock and saving, respectively. The households in this area have a tradition of bulking the products to collect the cash incomes in one or two payments in order to spend it on productive assets. They believe the income from frankincense creates wealth as it is earned with much effort and suffering. In Elnehud, the proportion of interviewed households' spending on agricultural inputs, livestock and saving was 37.7%, 27.9% and 11.5%, respectively. Unsurprisingly, the expenditure of gum and resin income on productive assets and capital accumulation is low in Ummrawaba and Borena. In Borena, gum and resin collectors usually sell their production weekly in small quantities and use the cash to buy household commodities. In Ummrawaba, households mostly used their gum income for covering household consumption needs, especially water. Only a few households spend the extra income from gum arabic for buying livestock (15%) and saving (15%). The way in which the households spent their extra gum and resin income clearly demonstrate the significant contribution of the activity in poverty mitigation as the revenue is mostly used to meet current consumption needs and fill income gaps [2,5]. On the other hand, the reinvestment of the extra income in productive assets and accumulating capital indicate the poverty reduction role of gum and resin production in the study areas. This finding concurs with that of Adam *et al.* [51], who reported the poverty mitigation and reduction role of commercial NTFPs in Sudan.

Figure 5. Proportion of households spending gum and resin income on major expenditure items (the percentages do not sum up to 100 as the extra gum and resin incomes are spent for more than one expenditure item).



According to the qualitative interviews and information from the group discussions, the timing and extent of the income, the economic status of the households and socio-cultural conditions of the community are the major factors determining how gum and resin incomes are spent by the household. Similar findings were reported in Sub-Saharan Africa on the factors determining the contribution of NTFPs to the livelihood strategies of rural communities [51,52]. The higher the income from gum and resins collected in one lump sum, the higher the probability that it is used for productive assets and capital accumulation. Moreover, households with higher total income from alternative sources tend to use their additional income from gum and resin for productive assets. The community in Abergelle gives high value for the income from frankincense believing that it creates wealth if spent on productive assets. On the contrary, the pastoralist community in Borena collects gum and resin mostly for filling their consumption needs. Of the two cases in Sudan, Elnehud and Ummrawaba, a large proportion of the households in Elnehud reported that they spent part of their gum and resin income for productive assets and capital accumulation. This could be attributed to the relatively better infrastructure, especially water reservoirs and higher income from livestock and crops to cover household consumptions so that the extra income can be used for capital accumulation. Surprisingly, most of the gum and resin income in Ummrawaba is spent on drinking water and household consumables.

3.6. Seasonality of Gum and Resin Income

Another interesting feature of gum and resin-based activities in the rural households' economy is related to the seasonality of production and the timing of the income. Gum arabic and frankincense are available exclusively during the dry season that lasts from 5 to 7 months coinciding with the agricultural slack period. An exceptional case is the additional minor collections—poor quality and small in quantity—of gum and resin during the rainy season in Borena. By their very nature, gum and

resin are not perishable. They can be stored for a long time if dried properly and stored in dry and aerated places. Despite these properties, the trade of the products at local markets is concentrated in the dry season. The seasonality of the production, collection and local markets make the gum and resin business compatible with the principal rural livelihood activities, crop and livestock production, which do not compete for labor except at the beginning of the tapping season. As described in the previous sections, these characteristics of the NTFPs are among the motivating factors for small-scale producers' entry into the activity.

In Borena, the income from livestock products declines during the dry season due to water and fodder shortages. Hence, gum and resin income is an important supplementary income to cover the household cash needs, which would otherwise be covered by selling livestock. The timing of gum arabic income in Elnehud and Ummrawaba also matches with the season when farmers need cash to buy agricultural inputs and for social events. Respondents in Abergelle also indicated that the frankincense income has a special contribution for farmers. The income coincides with the time when the farmers should pay the previous years' credit for agricultural inputs. This is the season when crop prices are the lowest because of the supply. Thus, farmers use the cash income from frankincense for paying back their credit while storing the crop production until the prices go up.

During the group discussion, the farmers stressed the social significance of gum and resin activities in helping them to work in their village instead of seasonal migration for off-farm laboring. It was also indicated that farmers mostly used gum and resin incomes to fill the household cash needs, storing their crop and livestock in anticipation of better prices. Besides the direct income benefits, gum and resin production are commonly used as collateral for accessing both formal and informal credits from traders and GAPAs to fill their seasonal income gaps. For example, the GAPAs in Ummrawaba and Elnehud provide credit to their members at the beginning of the tapping season to fill the critical income gap and finance the tapping activities, based on the size of gum garden owned. In Borena, it is very common to take household commodities as an advance payment or credit from local shopkeepers that will be paid in kind with gum and resin destined for the next market.

3.7. The Role of Gum and Resin Income in Poverty Mitigation and Reducing Income Inequality

The inclusion of gum and resin income in the household income accounting resulted in a noticeable reduction in poverty incidence in the case studies (Table 4). The results revealed that the additional income earned from gum and resin has contributed to the reduction of the poverty incidence by 23%–48% in the study areas. Similarly, gum and resin incomes contributed to the reduction of the measured income inequality between the households in the rural community. This was clearly manifested in Borena where the inclusion of gum and resin income reduced the *Gini* coefficient from 0.47 to 0.22 (Table 5), which is comparable to the contribution of aggregate forest income reported in Benin [53] and southeastern Ethiopia [48]. The high reduction in income inequality might be attributable to the higher dependence of poor households on gum and resin collection because of the open resource access and low barrier to entry. Instead, the contribution of gum and resin income in reducing income inequality was modest in the other case studies (with a range of 0.01–0.03 unit reduction, Table 5). This might reflect the even participation and income generation from gum and

resin production by both income groups. Still, the result is comparable with that of the 0.04 *Gini* units reduction due to forest income reported in Malawi [54].

Table 4. Poverty incidence (headcount index) and the effect of gum and resin income in reducing poverty incidence across the case study areas.

Case study area	Poverty incidence (headcount index)			National rural poverty incidence (headcount index)
	Without gum and resin income (a)	With gum and resin income (b)	% change ((a − b)/a) × 100	
Ummrawaba	30.0	16.7	44.4	57.9 [i]
Elnehud	13.3	8.3	37.6	
Abergelle	51.7	26.7	48.4	30.4 [ii]
Borena	73.3	56.7	22.7	

[i] [55] poverty incidence in North Kordofan, Sudan; [ii] [56] rural poverty incidence in Ethiopia.

Table 5. *Gini* coefficient with and without gum and resin income in the four case study areas, 2011/2012.

Cases	*Gini* without gum and resin income	*Gini* for total income	Change (*Gini* units)
Borena [a]	0.47	0.22	0.25
Abergelle [a]	0.28	0.25	0.03
Elnehud [b]	0.27	0.26	0.01
Ummrawaba [b]	0.18	0.21	0.03

[a] Ethiopia national rural *Gini* in 2011 = 0.27 [56]; [b] Sudan national *Gini* in 2009 = 0.35 [57].

As already discussed in the previous sections, in the open-access wild resource area (Borena) where the gum and resin market is not well developed and production is rudimentary, the value of the products is relatively lower so it is less attractive for the better-off households, which provides more opportunity for the poor. Gum and resin income is thus pro-poor and contributes greatly to narrowing the income disparities between rural communities. On the other extreme, gum arabic represents a high value commodity that needs land and initial investment for gum garden management, tapping and collection. Although both income quartile groups generate different levels of income from gum arabic production, the income potential of gum arabic production in Elnehud and Ummrawaba is more accessible for the middle income and better-off households. Despite the low reduction in the *Gini* coefficient in the three cases as compared to that of aggregate forest income in recent studies [49,53], the results suggest the potential of commercialization of the commodities to reduce income disparities among the rural communities if pro-poor interventions are devised. This was demonstrated in the case of Borena reflecting the pro-poor or accessibility of the income to the lower income segments of the rural community.

3.8. Determinants of Household Gum and Resin Income

The foregoing discussions disclosed that income generated from gum and resin varies greatly between sample households within and across the case study areas. The sets of socioeconomic factors explaining the inter-household variation in gum and resin income were identified using multiple regression analysis in each of the cases. The final models of the stepwise regression analysis resulted in the most significant predictor variables to be included in the models (Tables 6 and 7). ANOVA suggested the significance of the model fittings in all the cases (P = 0.000) and the adjusted R^2 were also fairly higher, thereby suggesting that the variance in gum and resin income is accounted for the significant independent variables included in the regression models.

Table 6. Multiple regression analysis of gum and resin income against household socioeconomic characteristics and contextual variables, Ummrawaba and Elnehud.

Case study area/model summary	**Ummrawaba (n = 60, R^2 *adj.* = 0.86, F = 91.54, P < 0.000)**			**Elnehud (n = 60, R^2 *adj.* = 0.62, F = 23.11, P < 0.000)**		
Independent variables	β	*t*	Sig.	β	*t*	Sig.
(Constant)		−0.291	0.772		2.030	0.047
Household head age (yrs)	−0.047	−0.892	0.376	−0.120	−0.146	0.150
Household size (No)	−0.050	−0.968	0.338	0.138	1.565	0.206
Household head education (Sch. yrs)	0.025	0.475	0.637	0.116	1.38	0.173
Total land holding (ha)	0.093	1.203	0.235	0.001	0.007	0.994
Gum garden area (ha)	0.740	11.103	0.000 **	0.339	3.700	0.000 **
Livestock holding (No)	0.035	0.643	0.523	0.267	2.145	0.036 *
Agricultural income (US$)	0.154	2.884	0.006 **	0.261	2.079	0.042 *
Off-farm income (US$)	−0.042	−0.757	0.453	−0.207	−2.272	0.027 *
Experience (yrs)	0.006	0.109	0.914	0.193	1.842	0.071
Storage (y/n)	0.067	1.348	0.184	0.042	0.424	0.673
Labor involved in production (No)	0.015	0.226	0.822	0.042	0.452	0.653
Distance to production area (min)	−0.176	−2.964	0.005 **	−0.118	−1.40	0.167
Cash orientation (%)	0.118	2.145	0.037 *	0.110	1.256	0.241

Dependent Variable: Gum and resin absolute income (US$); * significant at 95% significance level; ** significant at 99% significance level.

The results of the regression analysis indicated that the significant socioeconomic factors determining the household gum and resin income vary across the cases. Accordingly, gum garden area (P = 0.000), agricultural income (P = 0.006), distance to production area (P = 0.005), and cash orientation of the households (P = 0.037) significantly correlated with the dependent variable, gum and resin income, in Ummrawaba (Table 6). On the other hand, the significant predictor variables in Elnehud included in the final model were gum garden area (P = 0.000), agricultural income (P = 0.042), off-farm income (P = 0.027), and livestock holding (P = 0.036). Agricultural income and gum garden area were the common predictor variables in the two cases from Sudan. The explanation for the effect of gum garden area is straightforward: the larger the gum garden area the household owns, the higher the gum arabic production and hence income. As to the agricultural income, farmers

with higher agricultural income tend to generate higher gum and resin income. This could be attributed to the fact that when the farmers have higher income from agriculture, they tend to work on their gum garden during the agricultural slack period rather than looking for alternative off-farm labor income elsewhere. This was supported by the regression model of Elnehud where the off-farm income significantly and negatively related to gum and resin income.

Table 7. Multiple regression analysis of gum and resin income against household socioeconomic characteristics and contextual variables, Abergelle and Borena.

Case study/model summary	**Abergelle (n = 60, $R^2.adj$ = 0.663, F = 24.18, P = 0.000)**			**Borena (n = 60, $R^2.adj$ = 0.49, F = 12.39, P = 0.000)**		
Independent variables	β	*t*	Sig.	β	*t*	Sig.
(Constant)		3.093	0.003		2.152	0.036
Household head age (yrs)	0.086	1.042	0.302	−0.039	−0.316	0.753
Household size (No)	0.041	0.492	0.624	0.304	2.685	0.010 *
Household head education (yrs)	0.147	1.863	0.68	0.017	1.084	0.88
Land holding (ha)	−0.196	−2.494	0.016 *	na		
Livestock holding (No)	0.216	2.591	0.012*	−0.133	−1.097	0.278
Agricultural income (US$)	Exc.			−0.355	−3.151	0.003 **
Off-farm income (US$)	−0.027	−0.343	0.733	−0.298	−2.941	0.005 **
Production on own land (%)	−0.467	−5.849	0.000 **	na		
Distance to production area (min)	−0.008	−0.095	0.925	0.203	1.803	0.047 *
Experience (yrs)	0.232	2.673	0.010 *	0.160	1.475	0.146
Storage (y/n)	0.254	3.160	0.003 **	0.032	0.332	0.741
Cash orientation (%)	exc.			−0193	−2.004	0.05
Labor involved in production (No)	0.134	1.084	0.283	0.319	2.538	0.014 *

Dependent Variable: Gum and resin absolute income (US$); * significant at 95% significance level; ** significant at 99% significance level; exc: excluded in the analysis due to multicollinearity; na: not applicable.

In Abergelle, experience in gum and resin production (P = 0.010), land holding (P = 0.016), production on own land (P = 0.000), storage before selling (P = 0.003), and livestock holding (P = 0.012) were significantly related with gum and resin income (Table 7). Land holding and production on the farmers' own land were negatively related to the income from frankincense, while the effect of experience and storage was positive. The variables in this case are more related to access to production area in the natural *Boswellia* woodlands and market factor. During allocation of production areas, the multipurpose cooperative and local administrations give priority to households with good experience in frankincense production and less land. Similarly, farmers who possess *Boswellia* trees and stands on and around their farmland usually produce on their own land as they have less chance of being allocated production areas in the communal woodland. The longer the producers store their products towards the end of the production season, the higher the price they receive. As indicated by the respondents and the group discussions, the main reason for storing is anticipating better prices and bulking to collect the income in one lump sum.

In the fourth case, Borena, household size (P = 0.010), labor involved in collection (P = 0.014) and the distance travelled for collection (P = 0.047) were significant and positively related to gum and

resin income, while livestock income (P = 0.003) and off-farm income (P = 0.005) were negatively related to gum and resin income (Table 7). A possible explanation for the significant factors could be associated with the open-access woodland resource for collection of gum and resin. The critical factor in this case is the labor involved in production. The effect of household size is thus related both to the need for cash income and availability of labor. Distance travelled into the woodlands is also an important factor for higher production. The collectors travelling deep into the woodland collect more than those who collect from the nearby areas because there is less competition. Better-off farmers with higher income from livestock are less interested in gum and resin income due to the low return on labor as the price of the products in the region is not attractive. Finally, the off-farm income mostly generated from participating in the food for work programs negatively affect the gum and resin income due to the labor competition.

Despite the similarities in the nature of the commodities and their production systems and value in international market, the present findings indicate that income from gum and resin is affected by different socioeconomic and contextual factors in the four cases. This can be clearly observed from the significant variables in the final regression models and their direction of effects that varies across the cases (Tables 6 and 7). The inter-case variations in resource management regime, as well as the production and development of the local marketing systems could be cited as important factors conditioning the effects of socioeconomic and contextual variables affecting gum and resin income across the study areas.

4. Conclusions

Unlike many NTFPs that serve more as a supplementary income and safety net during critical times, gum and resin products in the drylands of Ethiopia and Sudan constitute an imperative livelihood source constituting 14%–23% of the total household annual income. Gum and resin production in the study areas are merely market oriented, providing an income opportunity that forms an integral part of the households' livelihood than the available other forest products mostly collected for subsistence. The comparative analysis confirms the assertion that NTFP extraction from domesticated resources provides more livelihood opportunities than those extracted from natural forests particularly in open-access conditions. The empirical results from the four cases indicate that when NTFPs are extracted in open-access resources with a poorly developed market, they are mostly accessible for the poor as *a last resort* option because of the low entry barrier. However, with the increased commercialization of NTFPs, better-off households benefit more from high value NTFPs than the poor owing to their better access to resources and market. Hence, pro-poor market development interventions can exploit the commercial potential of high value NTFPs, like gum and resin, for poverty alleviation and rural development.

The findings of the present analysis indicate the substantial potential to improve household incomes and livelihoods through gum and resin commercialization. This can be achieved through improving production, local value addition and post-harvest handling, improving resource access and market conditions, among others. The empirical evidence from the comparative analyses signifies that the way in which commercial NTFPs contribute to rural household economies is shaped by the socioeconomic and institutional contexts more than the nature and value of the product itself. Thus, development and

policy interventions targeting NTFP commercialization-based rural development and poverty alleviation need to pay considerable attention to the specific socioeconomic and institutional environment. In addition, an integrated approach is recommended to exploit the commercial opportunities of the NTFPs as they form an integral part of the livelihood of the rural community. In this regard, we recommend further research investigating the role of informal institutions and traditional knowledge in the current production and marketing systems, as these are crucial to formulate and implement compatible interventions.

A better understanding of the socioeconomic factors determining the role of NTFP income in the household economy is crucial for designing future conservation and income development initiatives. Several studies highlighted the influence of different socioeconomic factors on households' NTFP income [50,51,54,58]. However, these influences are variable and site specific, and cannot be generalized to all NTFPs, or to all socioeconomic and environmental conditions. The present results support this argument showing different socioeconomic and contextual factors affecting the households' gum and resin income across the four case study areas. It was observed that the contextual variables—including resource access and management, tenure rights, and marketing systems—conditioned how the different socioeconomic factors play into determining gum and resin income and relative dependence.

Besides the direct economic benefits, the woodlands are also highly valued for their environmental services. The high commercial potential of the commodities can create an incentive for conservation of wild resources, as well as encourage domestication and intensive management of resources on private lands. However, the absence of appropriate institutions and governance mechanisms, ecological knowledge of the tree species, and technical support might also lead to irreversible resource degradation from overexploitation. Therefore, in the face of the increasing international demand for gum and resins and the subsequent emerging opportunities, appropriate policy formulation and policy reforms, and innovation in governance and development interventions, has be put in place for supporting sustainable exploitation of commercial NTFPs while ensuring conservation and development of the resource base.

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Author Contributions

Asmamaw Alemu Abtew, Jürgen Pretzsch and Laura Secco identified the research question and designed the study. Asmamaw Alemu Abtew collected the field data and performs the analysis with

the guidance of the co-authors. All the co-authors assisted with the manuscript writing and revising the successive drafts.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Angelsen, A.; Wunder, S. *Exploring the Forest—Poverty Link: Key Concepts, Issues and Research Implications*; Centre for International Forestry Research: Bogor, Indonesia, 2003.
2. Belcher, B. Forest product markets, forests and poverty reduction. *Int. For. Rev.* **2005**, *7*, 82–89.
3. Neumann, R.P.; Hirsch, E. *Commercialisation of Non-Timber Forest Products: Review and Analysis of Research*; SMT Grafika Desa Putera: Bogor, Indonesia, 2000.
4. Shacklton, C.; Shackleton, S.; Butten, E.; Bird, N. The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. *For. Policy Econ.* **2007**, *9*, 558–577.
5. Wunder, S. Poverty alleviation and tropical forests—What scope for synergies? *World Dev.* **2001**, *29*, 1817–1833.
6. Ribot, J. Theorizing access: Forest profits along Senegal's charcoal commodity chain. *Dev. Chang.* **1998**, *29*, 307–341.
7. Marshall, E.; Schreckenberg, K.; Newton, A. *Commercialization of Non-Timber Forest Products: Factors Influencing Success: Lessons Learned from Mexico and Bolivia and Policy Implications for Decision-Makers*; UNEP World Conservation Monitoring Centre: Cambridge, UK, 2006.
8. Chidumayo, E.N., Gumbo, D.J. *The Dry Forests and Woodlands of Africa: Managing for Products and Services*; Earthscan: London, UK, 2010.
9. Ndumbe N. Markets and market chain analysis for Eru (*Gnetum spp.*) in Southwest and Littoral regions of Cameroon. Master Thesis, University of Buea, Buea, Cameroon, 2010.
10. Wollenberg, E.; Ingles, A. Methods for the Development and Conservation of Forest Products for Local Communities. In *Incomes from the Forest: Methods for the Development and Conservation of Forest Products for Local Communities*; CIFOR: Bogor, Indonesia, 1998; pp. 1–227.
11. Arnold, M.; Townson, I. *Assessing the Potential of Forest Product Activities to Contribute to Rural Incomes in Africa*; Natural Resource Perspectives: London, UK, 1998.
12. Peters, C.M.; Gentry, A.H.; Mendelson, S. Valuation of an Amazonian rainforest. *Nature* **1989**, *339*, 655–656.
13. Arnold, M.; Ruiz Pérez, M. Can non-timber forest products match tropical forest conservation and development objectives? *Ecol. Eco.* **2001**, *39*, 437–447.
14. Shackleton, S.; Campbell, B.; Lotz-Sisitka, H.; Shackleton, C. Links between the local trade in natural products, livelihoods and poverty alleviation in a semi-arid region of South Africa. *World Dev.* **2008**, *36*, 505–526.
15. FAO. *Non-Wood Forest Products for Rural Income and Sustainable Forestry*; Food and Agriculture Organization of the United Nations: Rome, Italy, 1995.

16. Jensen, A.; Meilby, H. Does commercialization of a non-timber forest product reduce ecological impact? A case study of the critically endangered *Aquilaria crassna* in Lao PDR. *Fauna Flora Int. ORX (Oryx)* **2008**, *42*, 214–221.
17. Kusters, K. Non-Timber Forest Product Trade: A Trade-Off between Conservation and Development. Ph.D. Thesis, Universiteit van Amsterdam, Amsterdam, The Netherlands, 2009.
18. FAO. *The state of the World's Forests*: *2003*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2003.
19. Vedeld, P.; Angelsen, A.; Sjaastad, E.; Berg, G. *Counting on the Environment: Forest Incomes and the Rural Poor*; Natural Resources Management and Development Portal: Washington, DC, USA, 2004; pp. 1–95.
20. Jensen, A. Valuation of non-timber forest products value chains. *For. Policy Eco.* **2009**, *11*, 34–41.
21. Woldeamanuel, T. Dryland resources, livelihoods and institutions: Diversity and dynamics in use and management of gum and resin trees in Ethiopia. Ph.D. Thesis, Wageningen University, Wageningen, The Netherlands, 2011.
22. Dorward, A.; Anderson, S.; Nava, Y.; Pattison, J.; Paz, R.; Rushton J.; Sanchez Vera, E. *A Guide to Indicators and Methods for Assessing the Contribution of Livestock Keeping to Livelihoods of the Poor*; Imperial College London: London, UK, 2005; pp. 1–95.
23. *Guidelines on Sustainable Forest Management in Drylands of Sub-Saharan Africa*; Arid Zone Forests and Forestry Working Paper No. 1; FAO: Rome, Italy, 2010.
24. Elmqvist, B. *Livelihood Diversification and Land Use Change in the SAHEL: An Interdisciplinary Analysis of Gum Arabic in Sudan*; Apelsin Publisher: Lund, Sweden, 2006; pp. 1–114.
25. Marshall, E.; Chandrasekharan, C. *Non-Farm Income from Non-Wood Forest Products*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2009; pp. 1–81.
26. Shackleton, S.; Paumgarten, F.; Kassa, H.; Husselman, M.; Zida, M. Opportunities for enhancing poor women's socioeconomic empowerment in the value chains of three African non-timber forest products (NTFPs). *Int. For. Rev.* **2011**, *13*, 136–151.
27. FAO. *Flavours and Fragrances of Plant Origin*; Food and Agriculture Organization of the United Nations: Roma, Italy, 1995; pp. 1–101.
28. Chikamai, B.; Casadei, E. *Production and Marketing of Gum Resins*; *Frankincense, Myrrh and Opoponax*; Food and Agriculture Organization of the United Nations: Nairobi, Kenya, 2005; pp. 1–97.
29. Chikamai, B.; Tchatat, M.; Tieguhong, J.C.; Ndoye, O. Forest management for non-wood forest products and services in Sub-Saharan Africa. *Discov. Innov.* **2009**, *21*, 50–59.
30. Awouda, E.H. *Development of Gum Arabic Production and Marketing in Sudan*; Food and Agriculture Organization of the United Nations: Khartoum, Sudan, 1999; pp. 1–86.
31. Lemenh, M.; Kassa, H. *Opportunities and Challenges for Sustainable Production and Marketing of Gums and Resins in Ethiopia*; CIFOR: Bogor, Indonesia, 2011; pp. 1–93.
32. Ahmed, M. The socioeconomic role of *Acacia senegal* in sustainable development of rural areas in the Gum belt of the Sudan. Ph.D. Thesis, Technical University of Dresden, Germany, 1999.

33. Eshete, A. The frankincense tree of Ethiopia: Ecology, productivity and population dynamics. Ph.D. Thesis, Wageningen UR, Wageningen, The Netherlands, 2011.
34. Worku, A. Population Status and Socio-economic Importance of Gum and Resin Bearing Species in Borana Lowlands, southern Ethiopia. Master Thesis, Addis Ababa University, Ethiopia, 2006.
35. El Tahir, B.A.; Mohamed, K.E.; Fadlalmula, A.G. Forest biodiversity in Kordofan Region, Sudan: Effects of climate change, pests, disease and human activities. *Biodiversity* **2010**, *11*, 34–43.
36. Friis, I.; Sebsebe D.; Breugel, P.V. *Atlas of the Potential Vegetation of Ethiopia*; Det Kongelige Danske Videnskabernes Selskab: Copenhagen, Denmark, 2010; pp. 1–307.
37. Coppock, D.L. *The Borana Plateau of Southern Ethiopia: Synthesis of Pastoral Research, Development, and Change, 1980–1991*; International Livestock Centre for Africa: Addis Ababa, Ethiopia, 1994; pp. 1–393.
38. Tussie, G.D. *Vegetation Ecology, Rangeland Condition and Forage Resources Evaluation in the Borana Lowlands, Southern Oromia, Ethiopia*, 1st ed.; Cuvillier: Göttingen, Germany, 2004; pp. 1–242.
39. Yin, R. *Case study Research*: *Design and Methods*; Sag Publications Inc.: Thousand Oaks, CA, USA, 2003; pp. 1–181.
40. Bryman, A. Integrating quantitative and qualitative research: How is it done? *Qual. Res.* **2006**, *6*, 97–113.
41. UNMDGI. United Nations Millennium Development Goals Indicators, 2012. Available online: http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=699 (accessed on 12 January 2012).
42. World Bank. Introduction to Poverty Analysis, 2005. Available online: worldbank.org/PGLP /Resources/PovertyManual.pdf (accessed on 17 September 2012).
43. Deaton, A. *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*; The Johns Hopkins University Press: London, UK, 1997; pp. 1–476.
44. Barrett, C.; Reardon, T.; Webb, P. Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. *Food Policy* **2001**, *26*, 315–331.
45. Ellis, F. Household strategies and rural livelihood diversification. *J. Dev. Studies* **1998**, *35*, 1–38.
46. Vedeld, P.; Angelsen, A.; Bojö, J.; Sjaatad, E.; Kobugabe, B. Forest environmental incomes and the rural poor. *For. Policy Eco.* **2007**, *9*, 869–879.
47. Babulo, B.; Muys, B.; Nega, F.; Tollens, E.; Nyssen, J.; Deckers, J.; Mathijs, E. The economic contribution of forest resource use to rural livelihoods in Tigray, Northern Ethiopia. *For. Policy. Eco.* **2009**, *11*, 109–117.
48. Yemiru, T.; Roos, A.; Campbell, B.; Bohlin, F. Forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. *Int. For. Rev.* **2010**, *12*, 66–77.
49. Prado Córdova, J.P.; Wunder, S.; Smith-Hall, C.; Börner, J. Rural income and forest reliance in highland Guatemala. *Environ. Manag.* **2013**, *51*, 1034–1043.
50. Hogarth, N.J.; Belcher, B.; Campbell, B.; Stacey, N. The role of forest-related income in household economies and rural livelihoods in the border-region of Southern China. *World Dev.* **2013**, *43*, 111–123.

51. Adam, Y.; Pretzsch, J.; Pettenella, D. Contribution of non-timber forest products livelihood strategies to rural development in drylands of Sudan: Potentials and failures. *Agricu. Syst.* **2013**, *117*, 90–97.
52. Shackleton S. The Significance of the Local Trade in Natural Products for Livelihoods and Poverty Alleviation in South Africa. Ph.D. Thesis, Rhodas University, Grahmstown, South Africa, 2005.
53. Heubach, K.; Wittig, R.; Nuppenau, E.A.; Hahn, K. The economic importance of non-timber forest products (NTFPs) for livelihood maintenance of rural West African communities: A case study from northern Benin. *Ecol. Eco.* **2011**, *70*, 1991–2001.
54. Kamanga, P.; Vedeld, P.; Sjaastad, E. Forest incomes and rural livelihoods in Chiradzulu District, Malawi. *Ecol. Eco.* **2009**, *68*, 613–624.
55. IMF. *Sudan: Interim Poverty Reduction Strategy Paper*; International Monetary Fund: Washington, DC, USA, 2013; pp. 1–92.
56. MOFED. *Development and Poverty in Ethiopia 1995–2011*; Ministry of Finance and Economic Development: Addis Ababa, Ethiopia, 2013; pp. 1–94.
57. Hamid, F.; Eltahir, M.N.; Abdelaziz, A.; Aden, A.A.H. *Poverty Assessment Northern Sudan*; ICARDA: Aleppo, Syria, 2012.
58. Marshall, E.; Newton, A.C.; Schreckenberg, K. Commercialisation of non-timber forest products: First steps in analysing the factors influencing success. *Int. For. Rev.* **2003**, *2*, 128–137.